APPENDIX F
ELEMENTS OF AN AIRWORTHINESS QUALIFICATION SUBSTANTIATION REPORT (AQSR)

F-l INTRODUCTION

AR 70-62, *Airworthiness Qualification of US Army Aircraft Systems*,(Ref. 1) requires that an Airworthiness Qualification Substantiation Report (AQSR) be published after successful completion of an airworthiness qualification program. The AQSR will be prepared by the Government organization which has engineering cognizance over the subject air vehicle. Format should be in accordance with (IAW) the appropriate organization's Standing Operating Procedure (SOP), and should contain, as a minimum, the following elements in subpars. F-2.1 and F-2.2.

Distribution statements as provided for in Department of Defense Directive Number 5230.24, *Distribution Statements on Technical Documents,* (Ref. 2) should be considered for use on sensitive technical information.

F-2 CONTENTS

F-2.1 ELEMENTS OF: VOLUME I - AIRWORTHINESS QUALIFICATION FINAL REPORT

F-2.1.1 INTRODUCTION*

F-2.1.1.1 PURPOSE

This element should define the primary and secondary purpose of this AQSR. Normally, the primary purpose of an AQSR is to document the results of the airworthiness qualification program(s) for an identified air vehicle and to provide the basis for the issuance of a Statement of Airworthiness Qualification (SAQ) in accordance with AR 70-62 (Ref. 1). The secondary purpose of the AQSR is to provide data and applicable references which can be used to evaluate subsequent changes to the identified air vehicle. For a modification program, this AQSR should provide the data for previously qualified, unmodified components or subsystems which need not be requalified.

F-2.1.1.2 APPLICABLE CONTRACTS

Current contract numbers and identifying data should be cited. In addition, when previous development contracts or modification programs have resulted in data significant to this AQSR, these contracts should also be cited. For example, development program fatigue test results for unmodified main rotor blades used in a later development program would be included in the AQSR. Test results from the original development program should be included in the AQSR, requiring citation of that development contract. results from the original development program should be included in the AQSR, requiring citation of that development contract.

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*The underlined portion of the paragraph number and title identifies the paragraph number and title in the AQSR.

F-2.1.1.3 EXECUTIVE SUMMARY

The executive summary should be in accordance with Government engineering organization SOP, but should contain, as a minimum, an overview of the system/subsystems/ components qualified, general types of testing accomplished, and the total ground and flight test hours completed. This element should provide a clear, concise statement of airworthiness qualification accomplishments upon which Department of Defense (DoD) executives outside the developing agency can base program decisions.

Significant program events which affected qualification should be cited or summarized, as should exceptions to full compliance with specifications and requirements. For example, a crash of a prototype or redesign of a major component or subsystem redesign which caused a program qualification delay should be identified. Additionally, failure to achieve specification objective, such as Vertical Rate-of-Climb (VROC), reliability, or stability requirements, should be cited, with appropriate waiver, deviation, or requirements/specification resolution information. The types of major controversy resolution which should be addressed include PM and test or evaluation agency disagreement on specification compliance, PM and contractor disagreement on responsibility for deficiency correction, prioritization of resources for deficiency correction, and logistics and maintenance difficulty resolution efforts caused by lack of qualified vendors.

Finally, areas in which the qualified systems far exceed requirements should be summarized.

The concluding paragraphs of the executive summary should provide a summary of the degree to which the aircraft or subsystems comply with specifications and requirements and recommendations concerning future program development, qualification, production, and/or operating and support efforts.

F-2.1.1.4 STATEMENT OF AIRWORTHINESS QUALIFICATION

The statement of airworthiness qualification (SAQ) should be included as an appendix to the AQSR. The SAQ, described in Appendix E to this handbook, should be referenced in this paragraph, and should cover the basic air vehicle or subsystem as defined in applicable specifications. The SAQ constitutes the final airworthiness release (AWR) issued in conjunction with the airworthiness qualification substantiation report (AQSR). Issuance of the SAQ normally completes the airworthiness qualification process. The SAQ should include an effective date which is defined as the date after which this SAQ or revision becomes effective. Configuration of the subject air vehicle should be defined by reference to contractor or Government specifications and drawing numbers, MWOs, TBs, approved Engineering Change Proposals (ECPs), etc. When individual air vehicles are configured differently, citation of a reference unique to one or more air vehicles shall identify, by serial number, applicable air vehicle. Other elements include airworthy operation, operating instructions and procedures, limitations and restrictions, sustaining airworthiness, inspections and frequency of inspection, limited life and flight safety parts, maintenance procedures, air vehicle logbook entries, and appendices, and are described in detail in Appendix E.

The SAQ constitutes the final airworthiness release (AWR) issued in conjunction with the AQSR. Subsequent changes to the air vehicle or subsystem should be covered individually,

and should require issuance of a separate AWR. AWR contents are described in Appendix D of this handbook.

F-2.1.2 DEFINITIONS

This element should contain, as a minimum, terms and definitions which are peculiar to this document. Definitions of terms defined in referenced publications need not be repeated here.

F-2.1.3 AIRCRAFT DESCRIPTION

This element of the AQSR should contain a general description of the air vehicle and its major subsystems or the subsystem being modified and its major components. For modification programs, only major subsystems or components changed from the baseline air vehicle require description. For developmental programs, plan view and profile drawings (with appropriate narrative) may be used to describe the air vehicle. When extensive information is required to describe the air vehicle, such information may be included in an appendix to the AQSR, with only summary information and reference to that appendix included in this paragraph.

F-2.1.4 AIRWORTHINESS QUALIFICATION PROGRAM

This element should contain two major subelements, Program Schedule and Test Program Summary. These subelements are described in the subparagraphs that follow.

F-2.1.4.1 PROGRAM SCHEDULE

This element should describe the overall test program schedule. The schedule may be depicted by a figure or table. As a minimum, the schedule can be an overall program schedule showing only major events and milestones that have occurred during the qualification program. Detailed schedules, including depiction of significant program events which have affected the schedule, may be used as appropriate. In most cases, the use of figures, such as Gant or PERT charts, make the interrelationship of tasks and events easier to understand. Whenever possible, the depiction of these events or tasks should have a key which allows consultation of detailed narrative for more information. Schedules should identify whether Government fiscal year or calendar year is used.

F-2.1.4.2 TEST PROGRAM SUMMARY

This element should contain a summary of ground and flight testing including the number of hours of ground and flight tests. The summary should cover the integration of static, fatigue, dynamic, ground, and flight tests to the maximum extent possible.

An example of units is a description of the integration of static, fatigue, and dynamic testing on flight critical components for a developmental program until all such components are qualified. Further description might include component integration into subsystems and ground test vehicles (GTVs) and further subsystem testing. Finally, flight testing of prototypes and appropriate production air vehicles to substantiate airworthiness qualification would be described. This description should include the deficiencies identified, corrections implemented and retested as necessary, and full documentation of all testing.

When new technologies are being developed, qualification of those new technologies may not have established procedures. Summaries of specification requirements, a description of

the methods for developing test and evaluation strategies, and description of new qualification methods employed should be included.

An example of such a new technology might be an artificial intelligence subsystem designed to reduce operator and or maintainer workload. Quantification of workload should be described, along with the evaluation criteria, criticality of functions performed, and allowance for error (including false alarm and failure to detect or act rates) for the subsystem. When tasks performed by the subsystem are critical to flight safety, results of safety assessments for the subsystem should be included.

F-2.1.5 STRUCTURAL DEMONSTRATION SUMMARY

The purpose of this element of the AQSR is to define the design flight, ground, and crash conditions used in structural demonstrations testing, and to summarize the results of that testing. The scope of this summary should include all flight and ground maneuvers, conditions during those maneuvers, conditions during the crash testing, and summaries of the data obtained using those maneuvers and conditions during the testing. Those element should contain a summary of the design conditions (with margins of safety [MOS] to indicate adequate strength for the applicable critical condition. Each development or modification program typically will dictate the contents of this summary. This element should be further divided into the following four subelements: design flight, groan, and crash conditions, and strength summary. Each subelement is described in the subparagraph that follow.

F-2.1.5.1 DESIGN FLIGHT CONDITIONS

The origin of the system's operational flight requirements should be described (required operational capability [ROC], operational requirements document [ORD], etc.). The process for converting this system's operational flight requirements to technical requirements may be described briefly. Derivation of requirements and test request, including margins of safety, should be summarized for flight maneuvers derived from operational requirements. Such flight maneuvers may include, but are not limited to:

1. Symmetrical dive and pullout
2. Vertical takeoff
3. Recovery from rolling pullout
4. Yawing, both steady sideslip and dynamic yawing
5. Positive gust, negative gust or maneuver
6. Autorotative pullout
7. Turn reversals.

Typical contents to be included with each condition include gross weight, lateral, longitudinal, and vertical center of gravity location, meteorological conditions, airspeed and normal accelerations (if so instrumented), dive and climb angles, angular rates and accelerations (if instrumented), initial conditions, and maneuver termination conditions.

F-2.1.5.2 DESIGN GROUND CONDITIONS

The origin (ROC, ORD, etc.) of the system's operational ground requirements should be described. The process for converting this system's operational ground requirements to technical requirements may be described briefly. Derivation of requirements and test results, including margins of safety, should be summarized for ground maneuvers used to verify that operational requirements are satisfied. Such ground maneuvers may include, but are not limited to:

1. Level landing
2. Nose down landing
3. Tail down landing
4. Main gear obstruction loads
5. Taxing and ground handling.

Typical contents to be included with each condition include gross weight, lateral, longitudinal, and vertical center of gravity location, meteorological conditions, ground speed, oleo and tire inflation pressures (if so equipped), angular rates and accelerations (if instrumented), initial conditions, termination conditions, loads on tow rings or plates, and ground slopes.

F-2.1.5.3 DESIGN CRASH CONDITIONS

The origin (ROC, ORD, system safety assessment, etc.) of the system's crashworthiness requirements should be described. (The process for converting these crashworthiness requirements to technical requirements may be described briefly. Typical contents to be included with each condition include gross weight, lateral, longitudinal, and vertical center of gravity location, meteorological conditions, airspeed and normal accelerations (if so instrumented), dive and climb angles, angular rates and accelerations (if instrumented), initial conditions, termination conditions, angles of impact, groundspeed at touchdown, oleo and tire inflation pressures (if so equipped), and ground slopes.

F-2.1.5.4 STRENGTH SUMMARY

Each of the major subsystems of the subject air vehicle should be listed, and will be further subdivided to list all critical components of that subsystem. Each critical component should be identified by part number (PN), nomenclature, margin of safety (MOS), flight, ground, or crash condition used to calculate that MOS, document which contains the MOS calculation, and page number of that document.

When extensive amounts of data are included, this summary may be provided as an appendix, with a summary of all components' MOSs provided in this paragraph. An example of this summary follows in TABLE F-1.

F-2.1.6 COMPONENT LIVES

As a minimum, this element should list component lives for critical components, and life units, such as flight hours (FH), months, cycles, etc. Data to support these calculations may come from structural analyses and flight loads surveys, and will typically be based on predicted or actual mission profiles using actual gross weights and center of gravity locations. Reports which contain these data should be referenced, and each component

TABLE F-1

STRENGTH SUMMARY FOR CRITICAL COMPONENTS

SOURCE: DERIVED FROM NARRATIVE DESCRIPTIONS IN ATCOM SOP 5-ED-1 DATED 11/17/92

PART NUMBER (P/N)	NOMENCLA-TURE	MOS (%)	CONDITION USED	DOCUMENT SHOWING MOS CALC	PAGE #
	ROTOR SYSTEM				
	Rotor System	12	Autorotative Pullout	S12345	12
12346789-1	Pitch Horn	15	Symmetrical Dive and Pullout	S12345	22
	LANDING GEAR				
124567890-11	Left Main Wheel Spindle	13	Limit Sink Speed, 10 Deg Left	S12456	77
	FUSELAGE				
125678901-13	Left Front Main Transmission Mount	10	Limit Sink Speed, 10 Deg Left	S12567	95

identified should identify the report and specific paragraph or page containing component life calculation. When extensive amounts of data are to be provided, these data may be contained in a table in the text or an appendix to the AQSR. An example of a summary is shown in TABLE F-2.

TABLE F-2
COMPONENT LIFE SUMMARY FOR CRITICAL COMPONENTS

PART NUMBER (PN)	NOMENCLATURE	COMPONENT LIFE (UNITS)	DOCUMENT SHOWING LIFE CALC	PAGE#
	ROTOR SYSTEM			
12345678-9	MAIN ROTOR BLADE	3432FH	S12345	23
12346789-1	PITCH HORN	6523FH	S12345	35
	LANDING GEAR			
124567890-11	LEFT MAIN WHEEL SPINDLE	24 MONTHS	S12456	99
	FUSELAGE			
125678901-13	LEFT FRONT MAIN TRANSMISSION MOUNT	5437FH	S12567	36

SOURCE: DERIVED FROM NARRATIVE DESCRIPTIONS IN ATCOM SOP 5-ED-1

F-2.1.7 OPERATING RESTRICTIONS This element should list or depict op erating limits and restrictions which appear in the operator's manual, and provide justification for those limits and restrictions. When extensive amounts of data will be provided, graphical presentation of limits should be considered. Where applicable, the reason for this specific limit, such as a test or analysis reference, should be cited. When multiple limitations conflict, an application criteria should be described.

Due to varying temperatures, pressure altitudes, gross weight s, and airspeeds, many of the limits are more clearly presented by use of a family of curves. For example, at a given temperature and pressure altitude, airspeed limitations at various gross weights may be depicted using a set of curves. Each curve represents predicted power required at various airspeeds. On the same curve, an engine or transmission limit may depict both maximum torque-limited airspeed and maximum airspeed due to power available. This curve is repeated at other combinations of temperature and pressure altitude, thus forming a family of curves.

Other limitations may be generally applied, with discrete sublimits under certain circumstances. An example may be maximum wind speed for engine starting. The general limit may be 30 knots, with lower limits when the wind is from the two aft quadrants relative to the aircraft nose. These sublimits may need to be graphically depicted in a chart.

As applicable, this paragraph should cover, but not be limited to, the following list of restrictions :

1. Minimum crew requirements should be addressed to define the Additionally, non-pilot crew members, such as crew chiefs, flight engineers, gunners, hoist operators, etc. required for ground or flight operation, should be identified.

2. Plots of permissible propeller, rotor, or prop rotor operating revolutions per minute (RPM) versus gross weight at various altitudes and airspeeds should be provided. Any other peculiar airspeed limitations, such as maximum airspeed allowable when opening cargo doors or with cargo doors open, should be specified.

3. Wind velocity limitations for starting and rotor engagement and sideward and rearward flight should be identified. Sideward and rearward flight limitations should be depicted graphically, showing, when available, data points used to establish limitations. Limitations on flight in specified turbulence conditions should be cited.

4. Continuous and maximum torque limits for engines and drive systems components should be defined. When one condition, such as transmission, exhaust gas temperature, etc., limits system torque, this condition should be identified, along with reference to substantiating data. Curves may be used to depict these limits.

5. Bank angle limits for normal operation and operation following selected subsystem's failures should be identified. An example would be a limitation on bank angle when one hydraulic system is inoperative.

6. Minimum and maximum rotor speed limits for normal operation, ground or flight idle, and autorotation should be identified. When applicable, maximum engine speed for rotor engagement and rotor brake application should be identified.

7. Left and right sideslip limits at various airspeeds should be identified.

8. When limited by sink rates, maximum rates of descent for vertical, autorotative, and roll-on landings should be identified.

9. Flight maneuver load factor limitations (Vn diagram) should be provided.

10. Gross weight versus center of gravity (CG) limit ations should be identified. When the permissible CG range changes with increasing gross weights, these limitations may be shown in a figure.

11. When applicable, cargo limitations should be identified. Cargo floor loading limitations (pounds per square inch [PSI], total load in cargo compartment, etc.) and maximum tiedown limitations should be listed. When tiedown limitations have different lateral, forward, or rearward values, this fact should be emphasized.

12. External cargo hook and rescue hoist limitations should be identified when applicable. These limitations should consist of maximum loads, hoist speeds, and number of cycles as appropriate.

13. Environmental restrictions, such as flight in icing conditions, should be identified.

14. Auxiliary power unit (APU) operating limitations should be identified. Examples of such restrictions are limitations on usage time, starting main engines, etc.

F-2.1.8 QUALIFICATION DATA SUMMARY AND INDEX

A qualification data summary and index should be included which lists all Government and contractor technical reports and data generated and used during this airworthiness qualification program. All qualification data, including development program contract deliverables, which provide substantiating data should be cited. Consequently, it is important to begin to build this database early in the development program, and continuously update the database throughout the qualification effort.

As a minimum, t his summary should contain the document identification number and title.

F-2.1.8.1 CONTRACTOR DATA

Entries in this element should include all airworthiness related data submitted in accordance with development and production program contract data requirements lists (CDRL). These entries are not limited to test reports, and will include all data significant to airworthiness qualification.

F-2.1.8.2 GOVERNMENT DATA

This list should cont ain all qualification significant data not just test reports. Test request, test plans, the safety assessment report, etc., should be included. This element should cite document identification number, title, and the agency preparing the report.

F-2.2 ELEMENTS OF: VOLUME II - SPECIFICATION COMPLIANCE BY PARAGRAPH

F-2.2.1 INTRODUCTION

Volume II should contain a paragraph-by-paragraph review of the s ystem control document(s) (detail specification, AQS, etc.) All items covered in the specification-test matrix of Chapter 2 of this handbook which affect airworthiness should be listed here.

F-2.2.2 PARAGRAPH COMPLIANCE LIST

Following applicable specification paragraph listing, a brief description of the requirement cited in that paragraph should also be included, along with a statement of

compliance or noncompliance and reference documentation. Additional comments may be included to provide more information on the paragraph or some aspect of compliance.

When extensive amounts of data are to be provided, a summary of compliance or noncompliance may be provided here, with reference to an appendix listing all compliance elements. A sample compliance list is provided at TABLE F-3.

TABLE F-3
PARAGRAPH COMPLIANCE LIST
SOURCE: DERIVED FROM NARRATIVE DESCRIPTION LIST

PARAGRAPH	REQUIREMENT	DEGREE OF COMPLIANCE
6.3.1.4.1 (a)	Completion of Fatigue Test on One Specimen for Each Critical Design Component	Partial IAW SAQ Para A.B.C.D(1)
6.3.1.4.1 (b)	Static Test to Limit Load for Critical Airframe Components	Full IAW SAQ Para A.B.C.D(2)
6.3.1.4.1 (c)	Flight Control Software Documonstration	Full IAW SAQ Para A.B.C.D(2)a
6.3.6.6.1.2	Bench Overstress Test of Main Transmission	Full IAW SAQ Para A.B.D.C(3)b
6.3.6.6.1.2	Bench Overstress Test of Canted Tail Rotor Gearbox	Full IAW Para A.B.D.C(3)b
6.3.7.1	Flight Loads Survey	Full IAW SAQ Para A.B.D.E(4)a

GLOSSARY

When a definition is not included in the text, a glossary of terms used in this appendix will be included. A list of acronyms used and their meanings should also be provided.

INDEX

An index should be provided which will allow location of major subjects within the AQSR. As a minimum, the index should list subjects and page numbers or appendices for all numbered elements of the AQSR.

APPENDIX F

LIST OF ACRONYMS AND ABBREVIATIONS

APU	=	auxiliary power unit
AQSR	=	airworthiness qualification substantiation report
AWR	=	airworthiness release
CDRL	=	contract data requirements list
CG	=	center of gravity
DoD	=	department of defense
ECP	=	engineering change proposal
FH	=	flight hours
GTVs	=	ground test vehicles
MOS	=	margin of safety
ORD	=	operational requirements document
PN	=	part number
PSI	=	pounds per square inch
ROC	=	required operational capability
SAQ	=	statement of airworthiness qualification
SOP	=	standing operating procedure
VROC	=	vertical rate-of climb

APPENDIX F
REFERENCES

1. AR 70-62, *Airworthiness Qualification of US Army Aircraft Systems*, 15 July 1978.

2. DoDD 5230.24, *Distribution Statements on Technical Documents*, 18 March 1987.